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**PHYTOTOXICOLOGY INVESTIGATION
IN THE VICINITY OF THE FORMER
PRESTOLITE BATTERY COMPANY
TORONTO, 1990**

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PRESTOLITE BATTERY COMPANY - TORONTO, 1990**

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Abstract

This survey, conducted in the early fall of 1990, found lead and cadmium concentrations in the surface soil in areas within about 300 meters of the former Prestolite Battery factory that exceeded the residential soil decommissioning guidelines of 500 ug/g and 4 ug/g, respectively. Some sample sites within about 150 meters of Prestolite had soil lead concentrations above the industrial decommissioning guideline of 1000 ug/g. The area affected is mostly residential. A more detailed soil survey will have to be conducted to better define the area of residential soil contamination.

Phytotoxicology Investigation In the Vicinity of the Former Prestolite Battery Company, Toronto, 1990

Introduction

Prestolite Battery Company operated a battery manufacturing facility at 1352 Dufferin Street in Toronto until approximately 1980, at which time a new facility was constructed in Concord. Over the years previous to the plant closing, the Phytotoxicology Section conducted a number of assessment surveys that showed Prestolite to be a major source of lead contamination. Soil and vegetation surveys in 1973 (Ref 1) and 1975 (Ref 2) indicated excessive concentrations of lead in both media in proximity to Prestolite, but did not indicate excessive concentrations of arsenic. Vegetation surveys in 1977 (Ref 3), 1978 (Ref 4) and 1979 (Ref 5) showed excessive lead concentrations near the factory, noticeably increased concentrations of cadmium, and slightly increased concentrations of arsenic and antimony.

The Central Region of the Ministry of the Environment, Toronto West District Office, requested that the Phytotoxicology Section conduct an assessment of soil lead concentrations in the vicinity of the former Prestolite factory in 1990 to determine if residual lead in the area warrants environmental concern.

Field Inspection

On September 5 and 6 of 1990, the Phytotoxicology Section conducted an investigation of the surface soils in the vicinity of the former Prestolite factory. The building now houses a large retail furniture outlet. A large area to the south of the building is a shopping centre covered in buildings and pavement, and to the south of that is the Wallace Emerson recreational complex, which was constructed after the decommissioning of an old factory. Although commercial and industrial uses exist immediately adjacent to the former Prestolite plant, residential areas are located nearby to the north and to the east.

Since the prevailing winds are from the northwest (winter) and from the southwest (summer), the survey plan had sampling stations extending along southwest to northeast and northwest to southeast axes. Single stations were placed between these axes to facilitate proper contour mapping of surface soil concentrations. The locations of sampling stations are mapped in Figure 1 and the actual locations are given in Appendix 1. Sampling was not conducted within one metre of fencelines, structures or painted surfaces. Sampling within 10 metres of major roads was avoided to minimize potential effects of roads. Also, sampling of parking lots and decommissioned lands was avoided in this survey. Since some of these considerations are different from those of previous surveys, since exact sampling locations from previous surveys were not able to be determined, and since sample preparation methods have changed, no attempt was made to link sampling sites with those of previous surveys. This allows the current survey to be completely independent of previous surveys.

Duplicate surface (0 - 5cm) soil samples were collected at each site using an Oakfield

soil corer. In situations where garden soils were taken, the depth increment was 0 - 15cm. At some sites, additional samples were taken at 5 - 15cm depth to determine the degree of contamination below the soil surface. All samples were returned to the Phytotoxicology Laboratory and prepared for analysis using standard Phytotoxicology protocols. They were then forwarded to the Laboratory Services Branch for analysis using an ICP scan for lead, cadmium, copper, nickel, zinc, iron, manganese, aluminum, cobalt, chromium, molybdenum, sodium, strontium and vanadium.

Results and Discussion

The initial analytical results showed very low lead concentrations at Station 7, indicating that the soil had recently been replaced or that clean topsoil had been placed on the property. This necessitated additional sampling in order for contour mapping procedures to produce meaningful results; hence, samples were taken at two additional sites on September 17, 1991. The analytical results for lead, cadmium, copper and nickel in surface soils (0 - 5cm and 0 - 15cm garden soils) are shown in Table 1.

Analytical results for all other elements for which analyses were conducted were similar to nickel in that they did not indicate any unusually high concentrations that may be related to the Prestolite operation. As a result, contour maps were not prepared for these elements. The data for zinc, iron, manganese, aluminium, cobalt, chromium, molybdenum, sodium, strontium and vanadium are summarized in Table 2.

A contour mapping program (Surfer, version 4, by Golden Software Inc.) was used to estimate spacial distributions of lead, cadmium, copper and nickel. These contour maps of metal concentrations are presented in Figures 2 - 5 (all maps were drawn using Kriging with normal search method for all points and smoothing with a tension factor of 2). Station 7 was not included in the mapping due to the soil replacement that has evidently occurred there. Figure 2 clearly shows a strong lead concentration gradient in the immediate vicinity of the former Prestolite factory. It should be noted that in Figure 2, the contour interval increases as the lead concentration increases; hence, the visual "height of the hill" has been reduced to avoid having too many contours. The contour map is being strongly driven by the Station 6 result of 3750 ug/g lead; however, the results at Stations 1 and 2 clearly indicate higher than normal concentrations of lead to the northeast, the main downwind direction. The results suggest that there are residential areas to the east, north and possibly to the west of Prestolite that have soil lead concentrations higher than normally present in urban areas (>500 ug/g) as a result of historic activities at Prestolite. In addition, there is a residential area south of Dupont Street and east of Dufferin Street which has also likely been impacted by lead contamination. The urban ULN is equal to the residential decommissioning guideline for lead (500 ug/g); hence, the contour mapping in Figure 2 suggests that these areas may have surface soil lead concentrations in excess of the residential decommissioning guideline. Areas in the more immediate vicinity of Prestolite may have soil lead concentrations in excess of the commercial/ industrial decommissioning guideline of 1000 ug/g. The area to the South of Prestolite has probably been impacted as well, but due to the abundance of buildings, roads,

Table 1: Concentrations of Metals in Surface Soils in the Vicinity of the Former Prestolite Battery Company, Toronto, 1990.

Station No.	Lead		Cadmium		Copper		Nickel	
	0 - 5 cm	5 - 15 cm	0 - 5 cm	5 - 15 cm	0 - 5 cm	5 - 15 cm	0 - 5 cm	5 - 15 cm
1*	<u>590</u>		1.3		70		22	
2 * back	<u>850</u>		2.3		74		30	
2 front	280		1.1		50		21	
3	285		1.3		42		22	
4	425	250	<u>4.9</u>	4.0	<u>165</u>	96	59	26
5	180		0.4		34		20	
6	<u>3750</u>		<u>19.5</u>		93		55	
7	31	410	0.3	0.7	24	40	22	27
8	170		1.2		88		23	
9	32	21	0.11	0.22	29	27	15	18
10	135		0.35		32		18	
11	245	310	1.1	0.95	40	43	16	20
12	165		0.67		31		21	
13	170	245	0.6	0.81	37	45	20	23
14	440		1.5		47		20	
15*	295		1.2		46		26	
16	<u>510</u>	675	1.5	1.6	51	55	23	27
17	255	260	1.2	1.4	34	43	20	23
18	325		1.3		45		24	
19	180		0.79		37		20	
20	125		0.54		36		20	
21	150		1.3		47		23	
22	165		1.1		30		24	
ULN	500		4		100		60	

All concentrations in ug/g dry weight - mean of duplicate results .

Sampling depth is 0 - 5cm, unless otherwise stated.

ULN - Phytotoxicology Upper Limit of Normal, urban soils, see Appendix 1

* Indicates sampling depth of 0 - 15 cm (i.e. a garden soil)

Table 2: Summary of Surface Soil Elemental Concentrations in the Vicinity of the Former Prestolite Battery Company, Toronto, 1990.

Element	Urban ULN	Minimum Value	Maximum Value	Station at which Maximum Reached
Zinc	500	57	790	2
Iron	-	14000	27000	4
Manganese	700	240	670	7
Aluminum	-	7900	19000	7
Cobalt	25	4.3	11	4,7,17,19
Chromium	50	19	58	8
Molybdenum	3	0.2	6.0	4
Sodium	-	130	520	15
Strontium	-	20	140	15
Vanadium	70	30	46	16

and paved parking lots, there is little soil left to be of significant concern with respect to lead contamination. The Wallace - Emerson Recreation Centre is on decommissioned lands and has been found to have low concentrations of lead in a recent Phytotoxicology survey (Ref 6).

Phytotoxicology Section complaint reports in 1975 showed lead concentrations in subsurface (5 - 10cm) soil to be consistently lower than those in the surface (0 - 5cm) soil for samples collected near Prestolite. In the current (1990) survey, this was not the case. Out of six stations where samples were taken at both the 0 - 5cm and the 5 - 15cm depths (this excludes Station 7 again) in 1990, four stations had higher lead concentrations beneath the surface than at the surface. This is likely indicative of both a general mixing of soils by soil organisms and downward movement of lead due to leaching or eluviation (movement of very fine particles). With minimal surface additions of lead over a ten year period, a net downward movement of the contaminant may have occurred. It is also possible that some properties may have had surface dressings of topsoil or compost that resulted in dilution of the lead contamination at the surface.

Figure 3 indicates a pattern of cadmium distribution in surface soil in the vicinity of Prestolite that is similar to that of lead. A definite zone of contamination above normal background concentrations (>4 ug/g) exists around the former factory. Previous survey reports have also cited elevated cadmium concentrations in the area. As was the case for lead, the residential decommissioning guideline for cadmium is equal to the urban ULN of 4 ug/g; hence, there are residential areas near Prestolite in which surface soils exceed the residential decommissioning guideline. There are also some areas in which surface soils

exceed the industrial decommissioning guideline of 8 ug/g.

Both cadmium and lead concentrations at Station 14, which is approximately 600 m SSW of Prestolite, were higher than would be anticipated based on results from the other sample locations at similar distances from Prestolite. Since this site was one of four reference stations chosen because of their remoteness from Prestolite and would, therefore, be expected to have low concentrations of these two contaminants, the possibility of an additional source of contamination to the west of this site exists. A 1975 Phytotoxicology Section report (Ref 2) cited an additional zone of lead contamination near Lansdowne and Dupont. There are a number of industries on the west side of Lansdowne Avenue that may have historically been sources of contamination. It should be noted that lead concentrations on old residential properties are highly variable and that the elevated concentrations encountered at Station 14 may have resulted from site specific causes.

The contour maps of surface soil copper (Figure 4) and nickel (Figure 5) concentrations do not show consistent contamination gradients relative to Prestolite. The highest concentrations of these elements were found at Station 4, immediately adjacent to a power line, and are potentially associated with the lines and towers. However, the exceedence of the urban ULNs for molybdenum and cadmium at this site indicate a potential localized source of contamination.

Conclusions

This survey found lead and cadmium surface soil concentrations in areas within about 300m of the former Prestolite Battery factory to be in exceedence of residential soil decommissioning guidelines. Some surface soils within about 150m of Prestolite contain lead and cadmium concentrations in excess of the commercial/industrial decommissioning guidelines. There is some evidence that the contaminants have moved downward into the soil profile; however, the contamination is likely to remain a potential concern for many decades. Appendix 2, a fact sheet on soil lead contamination, provides additional information on soil lead exposure.

This survey was not designed to determine the extent of soil contamination problems for all individual properties near the Prestolite factory. The areas of contamination illustrated in Figures 2 through 5 are estimates from the software mapping program based on sampling of selected sites. The actual soil concentrations are known only at the sampled locations. To more fully assess and delineate the zone of soil lead contamination a more detailed survey would be required. This would involve sampling in the following areas;

- 1) Brandon Ave. (between Dufferin St. and 75 Brandon Ave).
- 2) Dufferin Ave. (between Chandos Ave. and across from the Wallace - Emerson Community Centre).
- 3) Bristol Ave. (between Geary Ave and about 75 Bristol Ave).
- 4) Geary Ave. (between its west end and Bartlett Ave).
- 5) Lightbourn Ave. (between its south end and Brandon Ave).

- 6) Dupont St. (between Emerson Ave. and Bartlett Ave., where appropriate sites exist).
- 7) Gladstone Ave. (between its north end and about 800 Bartlett Ave).

References

- Ref 1 A Report on 1973 Phytotoxicology Surveillances in the Vicinity of Prestolite Batteries, 1352 Dufferin St., Toronto. Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment., Nov 16, 1973.
- Ref 2 Vegetation and Soil Assessment surveys in the Vicinity of Prestolite (Eltra of Canada), 1352 Dufferin St., Toronto, 1975. Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment, Sept. 10, 1976.
- Ref 3 Vegetation and Soil Assessment Surveys in the Vicinity of Prestolite (Eltra of Canada) 1352 Dufferin St., Toronto, 1974 - 1977. Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment, Dec. 5, 1978.
- Ref 4 Lead and other Metals in Vegetation in the Vicinity of Prestolite (Eltra of Canada) 1352 Dufferin St., Toronto, 1978. Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment, Jan. 21, 1979.
- Ref 5 Lead and other Metals in Vegetation in the Vicinity of Prestolite (Eltra of Canada) 1352 Dufferin St., Toronto, 1979. Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment.
- Ref 6 Soil Investigation in the Proposed Location of a Community Garden at the Wallace - Emerson Community Centre - April 30, 1991, Phytotoxicology Section, Air Resources Branch, Ontario Ministry of the Environment. ARB-111-91-PHYTO

Figure 1: Map Showing Locations of Sampling Stations in the Vicinity of the Former Prestolite Battery . Toronto, 1990.

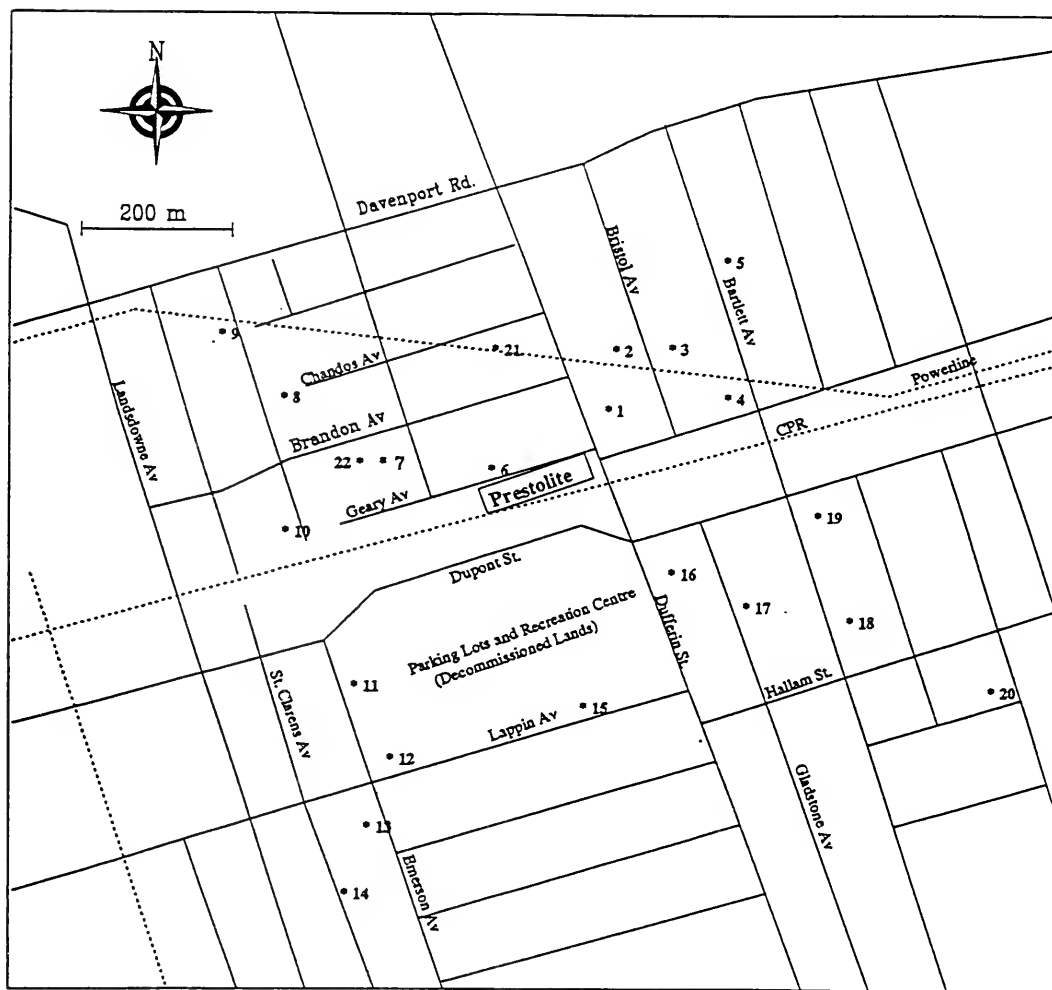


Figure 2: Contour Map of Surface Soil (0 - 5 cm) Lead Concentrations (ug/g) in the Vicinity of the Former Prestolite Battery Factory - Toronto, 1990.

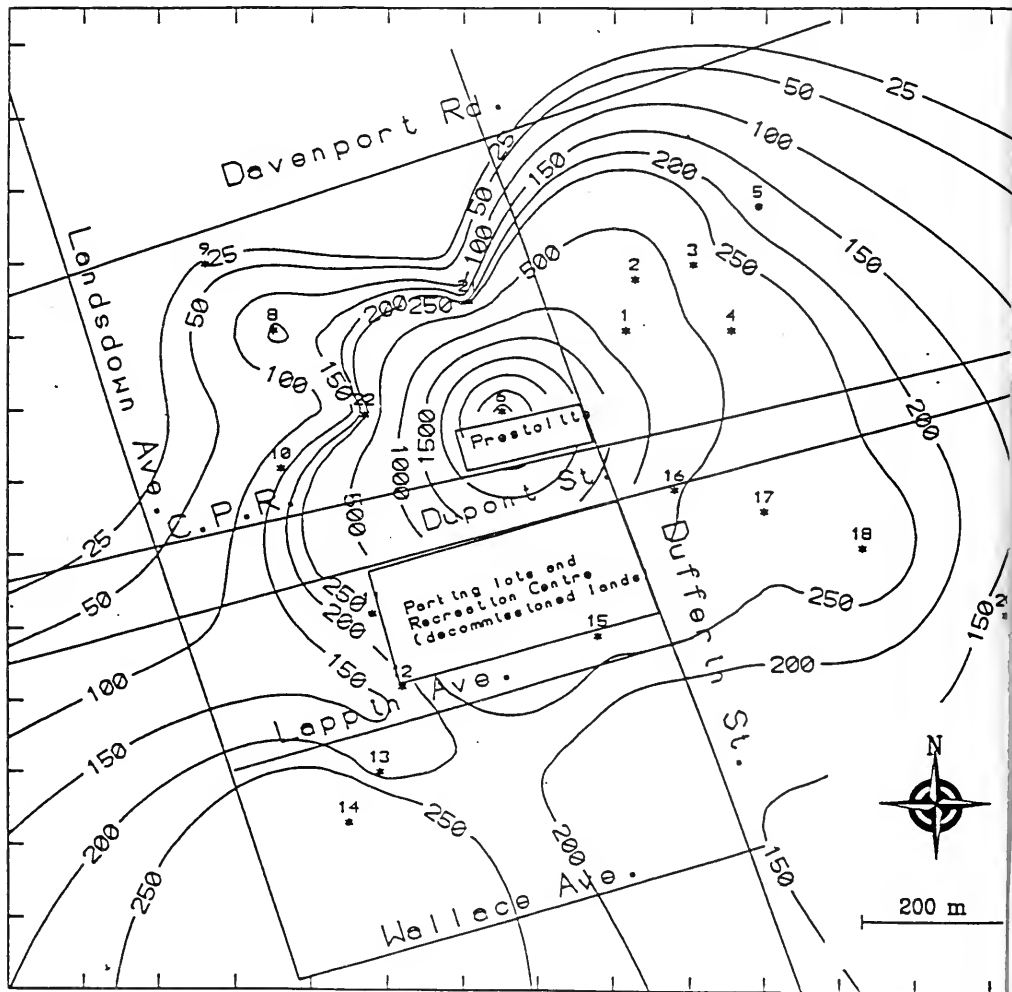


Figure 3: Contour Map of Surface Soil (0 - 5 cm) Cadmium Concentrations (ug/g) in the Vicinity of the Former Prestolite Battery Factory - Toronto, 1990.

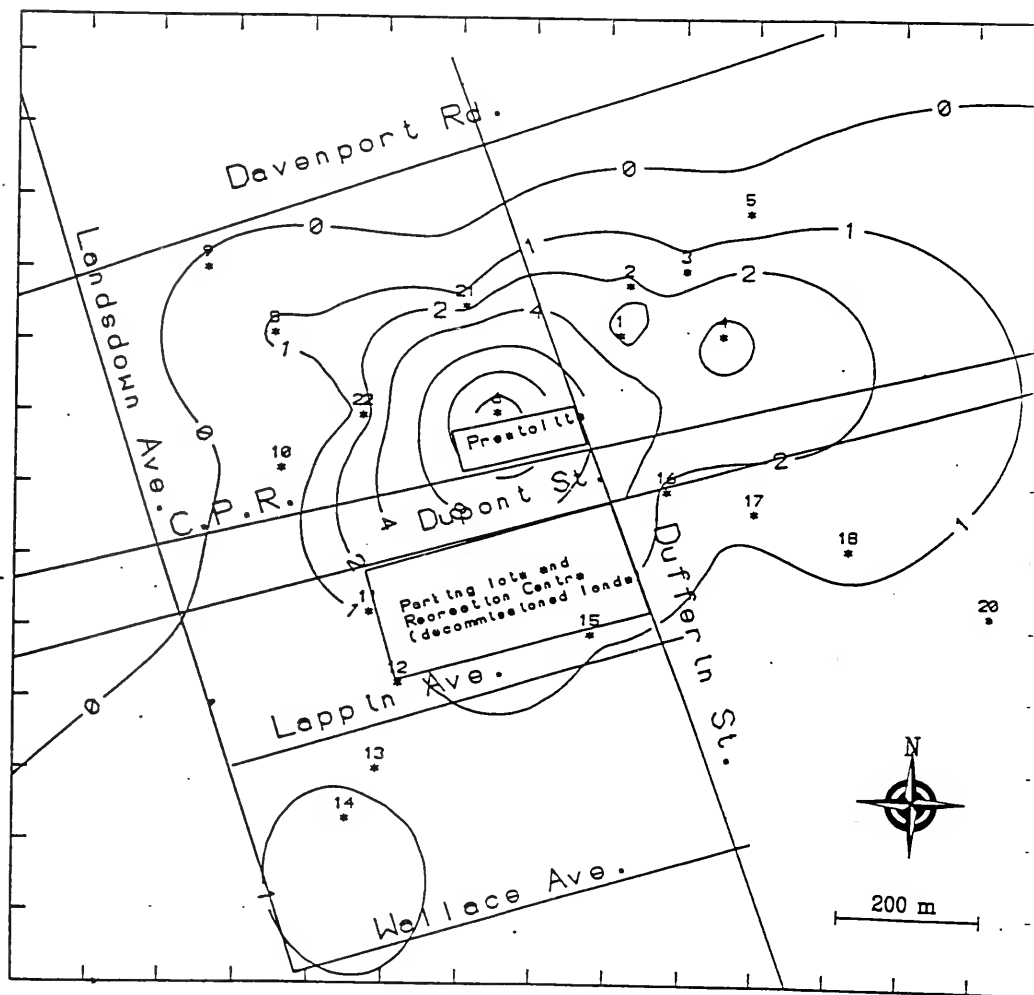


Figure 4: Contour Map of Surface Soil (0 - 5 cm) Copper Concentrations (ug/g) in the Vicinity of the Former Prestolite Battery Factory - Toronto, 1990.

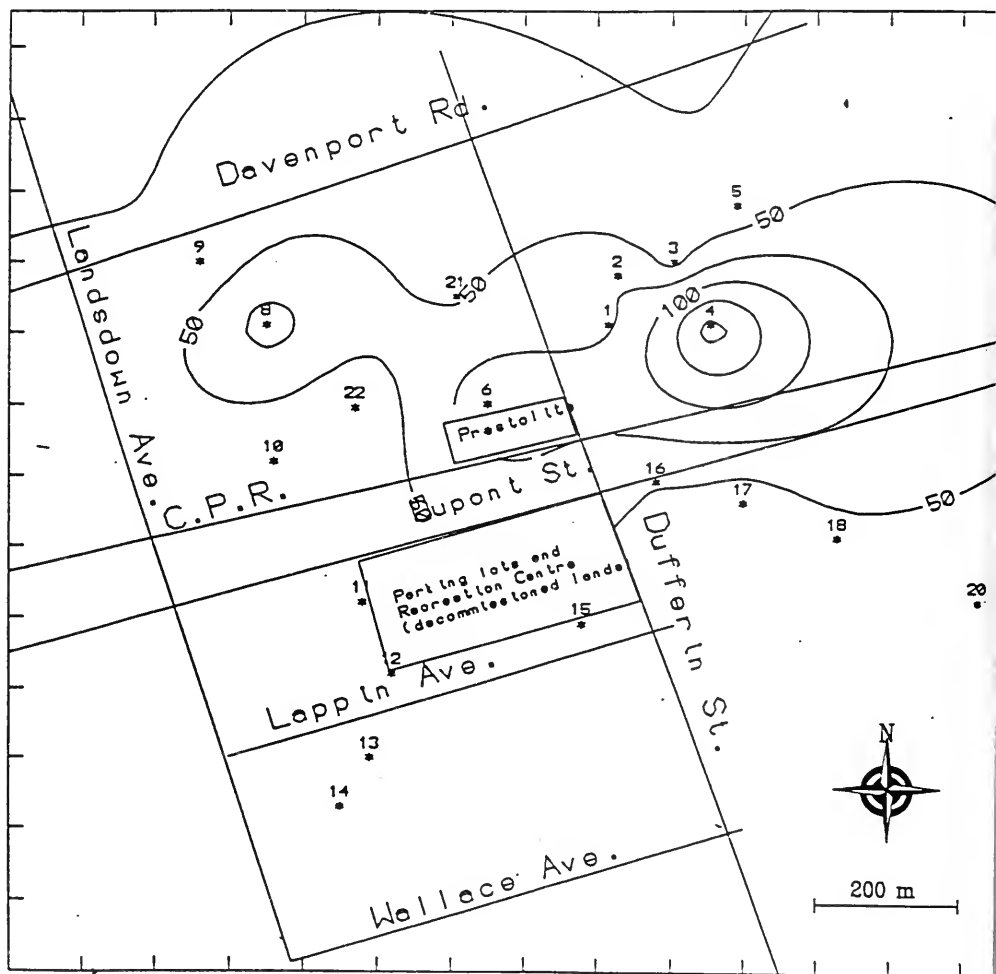
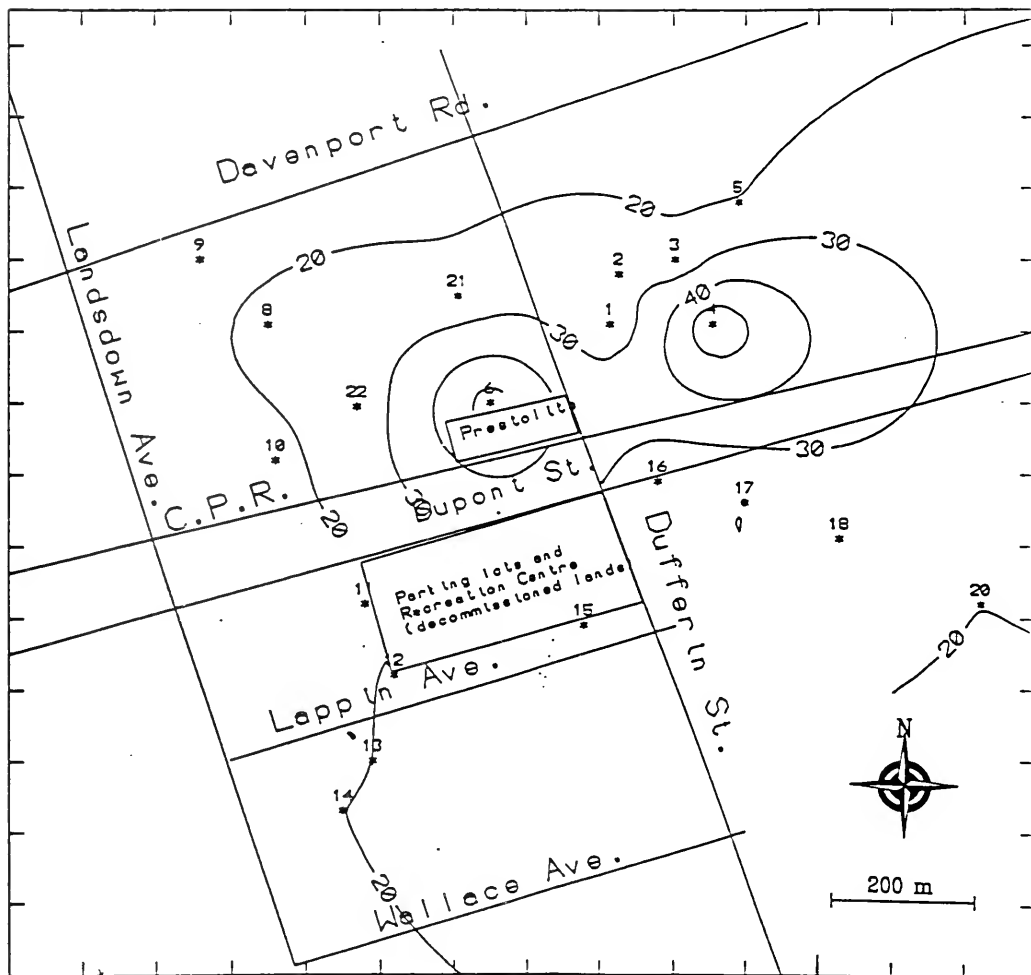


Figure 5: Contour Map of Surface Soil (0 - 5 cm) Nickel Concentrations ($\mu\text{g/g}$) in the Vicinity of the Former Prestolite Battery Factory - Toronto, 1990.



Appendix 1

Derivation and Significance of the MOEE Phytotoxicology "Upper Limits of Normal" Contaminant Guidelines.

The MOEE Upper Limits of Normal (ULN) contaminant guidelines represent the expected maximum concentration in surface soil, foliage (trees and shrubs), grass, moss bags, and snow from areas in Ontario not exposed to the influence of a pollution source. Urban ULN guidelines are based on samples collected from urban centres, whereas rural ULN guidelines were developed from non-urbanized areas. Samples were collected by Phytotoxicology staff using standard sampling procedures (reference: *Ontario Ministry of the Environment. 1989. Ontario Ministry of the Environment "Upper Limit of Normal" Contaminant Guidelines for Phytotoxicology Samples. Phytotoxicology Section, Air Resources Branch: Technical Support Sections NE and NW Regions, Report No. ARB-138-88-Phyto. ISBN: 0-7729-5143-8.*). Chemical analyses were conducted by the MOEE Laboratory Services Branch.

The ULN is the arithmetic mean plus three standard deviations of the suitable background data for each chemical element and parameter. This represents 99% of the sample population. This means that for every 100 samples that have not been exposed to a pollution source, 99 will fall within the ULN.

The ULNs do not represent maximum desirable or allowable limits. Rather, they are an indication that concentrations that exceed the ULN may be the result of contamination from a pollution source. Concentrations that exceed the ULNs are not necessarily toxic to plants, animals, or people. Concentrations that are below the ULNs are not known to be toxic.

ULNs are not available for all elements. This is because some elements have a very large range in the natural environment and the ULN, calculated as the mean plus three standard deviations, would be unrealistically high. Also, for some elements, insufficient background data is available to confidently calculate ULNs. The MOEE Phytotoxicology ULNs are constantly being reviewed as the background environmental data base is expanded. This will result in more ULNs being established and may amend existing ULNs.

Appendix 2 : Soil Lead Information

Lead is not necessary for normal body function (iron is an example of an essential dietary nutrient). Recent studies have suggested that there may be some risk at very low levels of exposure. Lead in the environment can come from many sources, such as industrial emissions, vehicle exhaust, and peeling or flaking paint. Therefore, people are exposed daily to small amounts of lead. Young children and the developing fetus are the most sensitive to the toxic effects of lead. Environmental lead concentrations are usually much higher in urban areas. Soil contaminated with lead also may be contaminated with other elements, such as zinc, cadmium, arsenic, and antimony. This information sheet deals only with lead.

The experimental data developed by the Phytotoxicology Section of the Air Resources Branch, and the scientific literature, suggest that some vegetables will take up lead from the soil. Generally, the amount of accumulated lead is greatest in roots (eg. beet, carrot, onion, potato, radish), lower in stems and leaves (eg. celery, chard, lettuce, cabbage), and lowest in fruit (eg. tomatoes, berries, apples, bean, cucumber). The amount of lead that accumulates in the vegetables depends on the kind of vegetables grown, the soil characteristics, the garden management practices, and the soil lead concentration. The lead concentration in vegetables increases with plant age. It is generally accepted that there is minimal risk in consuming vegetables grown in soil with a lead concentration below 500 parts per million (ppm). The following table is a guide for planting and eating vegetables in soil with varying lead concentrations.

Guide for Planting and Consuming Vegetables

Soil Lead Concentration Parts Per Million	Root	Leaf ¹	Fruit
1 - 500	M	M	M
501 - 1000	R	M	M
1001 - 1500	A	R	R
greater than 1500	A	A	A

M -minimal risk (wash thoroughly)

R -reduced consumption (wash thoroughly)

A -avoid consumption/avoid planting

¹ -lettuce may accumulate lead more readily than other leafy produce

To minimize soil and vegetable lead contamination always locate vegetable gardens away from roadways, driveways, downspouts and sources of flaking or peeling paint. All vegetables should be thoroughly washed before consumption. The above table is only a guide; consuming vegetables grown in lead contaminated soil increases the exposure to environmental lead and is at the home owner's risk.

Children will ingest soil while playing. Recent medical evidence has determined that children under six years old will develop elevated blood lead levels by playing in soil with lead concentrations of 1,000 ppm and higher. Because the child's blood lead level is related to their total environmental lead exposure, the relationship between soil lead and blood lead is not precise. Therefore, where other potential lead sources exist, there may be some risk to children exposed to soil with lead concentrations below 1,000 ppm. Elevated blood lead levels in children inhibits enzyme activity in red blood cells, impairs vitamin D synthesis in the kidney, and impairs normal neurobehavioral development. More serious effects can occur at higher environmental lead exposure.

To minimize lead exposure to young children, access to lead contaminated soil should be restricted and the child's hands should be thoroughly washed after playing outdoors. Lead exposure from soil can be substantially reduced by removing the contaminated soil (three to six inches is usually sufficient), covering it with clean soil and sod, or covering it entirely with a solid material such as pavement, paving stone or wood. The home owner should contact a local Environment Ministry official for advice regarding the disposal of soil with high lead concentrations. Concerns about personal lead exposure should be discussed with a doctor.

